SCIENCE

VOL. 93 FRIDAY, APRIL 25, 1941 No. 2417

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.
New York City: Grand Central Terminal

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

PLANT RESEARCH AND HUMAN WELFARE[1]

By Dr. E. C. AUCHTER

CHIEF OF THE BUREAU OF PLANT INDUSTRY, U. S. DEPARTMENT OF AGRICULTURE

INTRODUCTION

WHEN this country was founded, nineteen people out of every twenty had to spend all their time producing food for themselves and the twentieth person. That was true all over the world. A hundred years ago eight people out of every ten still had to work with the soil, producing food for themselves and the other two people. To-day this proportion is exactly reversed. About two people out of every ten produce the food for the whole ten, or, putting it in another way, one person on the land supports himself, three people in town and contributes to the support of one person overseas.

What is the significance of this fact? Just this: When nineteen people out of twenty have to spend their energy producing food, that leaves only one person to produce everything else. Obviously there won't be much else; certainly there won't be any large-scale industries such as we know to-day. But when only two people out of ten have to produce food, the other eight are released to do a multitude of things. Large-scale factory production becomes possible. All kinds of social services become possible.

In brief, the degree of development of any society depends on the sufficiency of its agricultural resources and the efficiency of its farmers. Only where farmers are efficient and can release other men from the absolute necessity for devoting their time to primary production can the industries, sciences and arts that characterize modern civilization be developed. Our civilization in the United States to-day rests solidly on the achievements of farmers. These achievements

[1] Address before the Kansas Academy of Science, Wichita, Kansas, March 29, 1940.

have made it possible for two people to feed eight others besides themselves.

It has been done through science and engineering skill. Machinery and engineering enabled farmers to produce far more than they used to with the same amount of work. But along with advances in engineering during the past century there have been rapid advances in plant science. The present efficiency of agriculture would not have been possible without a new knowledge of soils and fertilizers and their effects on plants, and a new power to breed more productive plants—plants resistant to disease and other adverse conditions and adapted specifically to machine production. The plant scientist developing a bread wheat that could be grown here on the plains of Kansas contributed as truly to our present civilization as the engineer working out methods for the line production of automobiles.

It may be thought at this point that in spite of all this scientific progress, there are surplus farm products and large numbers of unemployed in the cities. Has science done too good a job? Has it made production too efficient? I think we can answer those questions in this way. If fault there is, it lies not with science but with the use made of science by society. Farmers have not yet produced more of anything than the people of the world actually need—if it were available to them. Every study of standards of living and of consumption shows that people could use more of almost all farm products than they have. The need is not for science to let up in its search for better and more efficient methods of production; the need is to find truly scientific methods of distribution. People with more remunerative employment will purchase more food products. It is desirable now to use the kind of science necessary to build an efficient bridge between production and utilization, rather than to dispense with any of the sciences. The fight against insects, diseases and environmental conditions will probably never be finished. New problems will constantly be arising which will require even better scientific methods for their solution, if we are to maintain the progress made to date.

Why is progress in plant science so important to human welfare? It is the capacity of green plants for manufacturing food—for accumulating energy as food—that makes them the foundation of any system of economy dealing with living things. When plant foods are eaten by human beings and animals, the compounds are broken down in their bodies, energy is made available for growth and movement and parts of the original compounds are again released into the air in the form of carbon dioxide and moisture or returned to the soil. These end products can again be used by plants in building new plant bodies and thus a "wheel of life" is established.

When I think of this "wheel of life," it seems to me that in the past, scientists have neglected the interrelationship between soil and plant, animal and human nutrition. We have been prone to consider the problems of each separately rather than to consider them as segments of the whole.

Early in the development of modern science, specialization became necessary, and to-day we have reached the point where the whole of science is rather minutely departmentalized. Each department has its own language and traditions and pursues its own objectives. By this method, we have accumulated a vast amount of information—for example, regarding the classification, chemical and physical properties and management of soils; and regarding the growth and reproduction of plants and animals. Chemistry, physiology, anatomy, pathology, physics, genetics, bacteriology and other sciences have all contributed to our knowledge of these subjects but each in its separate department without full consideration of a coordination of effort to the broader problems of human welfare.

That method was necessitated by the vastness and complexity of the facts with which science deals, and it is still necessary. But a concept of the unity of nature is no less important than a knowledge of its elements and its complexity, and the time has come when we shall have to devote more attention to a resynthesis of the many facts which are being uncovered but without neglecting the various fields of specialization. Some of the newer methods which seem desirable in attacking our plant and nutritional problems in the future may be pointed out.

To illustrate some specific accomplishments of plant science in their relation to human welfare I shall use illustrations taken from the experiences of the Department of Agriculture and the agricultural experiment stations. To emphasize how the present and the future utilize the past, let it not be overlooked that modern accomplishments are based on fundamental discoveries made by the great scientists of the past.

To-day there are few "plant scientists" in the old original sense. Such a multitude of discoveries have been made that we now have geneticists, pathologists, soil technologists, botanists, horticulturists, agronomists and specialists in other fields. By working together, they have been and are able to apply their various specialties to the solution of important basic and applied problems. But there is still need for more closely coordinating the various specialized efforts in an attack on many of the problems.

NATIVE AND INTRODUCED PLANTS

Now to come to the Department of Agriculture. Long before the establishment of the department, our national leaders recognized the necessity of bringing

to this country important plants from the Old World. The earliest governmental recognition of this appears in 1819, but in 1827 a Treasury circular was issued that required "consuls to collect and transmit seeds and plants, with information regarding climate, soil propagation, cultivation, insect pests and uses, and agricultural literature." The Secretary of the Navy asked naval officers to assist in this work. In 1839, there was established by Congressional action an "agricultural depository in the Patent Office," at that time in the State Department. In that office Commissioner Ellsworth (appointed in 1835) was already conducting plant explorations and bringing in importations, which led to the placement of new materials in "every part of the Union." From this beginning the Department of Agriculture developed.

Thus the very first work done by the Department of Agriculture was in connection with plant exploration and introduction. For many years the Division of Plant Exploration and Introduction of the Bureau of Plant Industry has continued to search the four corners of the earth to find new plants that would be of value for various purposes in this country. It is especially fitting to note here that the man who organized and directed this work for several decades received much of his collegiate training in Kansas, Dr. David Fairchild, whom many of you know and who in the last few years has published two extremely interesting books covering many of his foreign expeditions—"Exploring for Plants" and "The World Was My Garden."

Many of the crops grown to-day are taken for granted. Few people realize the part the Department of Agriculture has played in their introduction. Thus Korean Lespedeza, many of the clovers, most of the soybean varieties, Sudan grass, crested wheat grass, crotolaria, Austrian winter peas, navel oranges, dates, sorghums, Egyptian cotton, the tung tree, Ephedra, Oriental chestnuts and many of the hard red winter wheats are only a few of the crops that have been introduced.

Then came another phase of the story. With the improvement of highways, the extension of railroads, the development of refrigeration and cold storage facilities and the opening of new areas of the country, greater concentrations of crops were planted in many areas. Inevitably, diseases and insects, drought, cold injury, alkaline lands and other factors became important in limiting production and causing financial losses.

These conditions necessitated a gradual change in some of the objectives of the Division of Plant Exploration and Introduction, and in the coordination of efforts of investigators trained in the various scientific fields. In many cases in recent years the objective of the plant explorers has been, not primarily to bring back plants from which new crops could be developed but rather to find certain plants that gave promise of being resistant to some of the many diseases or other adverse factors affecting the profitable production of our present crops. With such resistant plants available, specialists could either use them directly or, through breeding, could develop hybrids or derivatives that could be substituted for the less resistant plants. How well this has been done is illustrated in some of the following examples.

Some Recent Accomplishments of Plant Scientists

A few years ago a new mosaic disease threatened the sugarcane industry of Louisiana. The usual methods of controlling plant diseases, such as spraying, crop rotation, etc., were unsuccessful. Production dropped from 250,000 tons of sugar annually to about 50,000 tons. Growers, manufacturers and distributors were faced with ruin and called upon the Department of Agriculture for aid. Our plant explorers visited other countries where sugarcane was grown and were fortunate in finding a wild cane in Java that had the ruggedness to resist this serious disease. Crosses between this wild cane and our domestic varieties resulted in new strains carrying both resistance to the disease and desirable commercial qualities. The sugarcane industry of Louisiana, worth $15,000,000 annually to the growers, was saved, and the working people dependent on cane for employment and thus a living in that area were not thrown out of work.

An excellent parallel to the sugarcane story is the striking success of the plant breeders who have developed strains of sugar beets for the Western States that can grow and produce abundant crops in spite of the curly-top disease. Although not so dramatic perhaps as the last-minute rescue of the sugarcane industry, the development of curly-top resistant beets made it possible to continue the production of the principal cash crop for thousands of farmers in California, Colorado, Idaho, Oregon, Utah, Washington and other states. It is estimated that two thirds of the acreage in these states is now planted to resistant varieties developed cooperatively by the department and state experiment stations.

The use of lettuce has in recent years become general in many homes but few people realize that a few years ago the entire lettuce industry of the Southwest, which produces half of the commercial crop, was threatened by a disease known as brown blight. Growers again turned to the Department of Agriculture and the state experiment stations for assistance. Plant explorers found resistant strains and then the

plant breeders and pathologists were able to combine these strains with those grown locally to produce a variety that was disease resistant and commercially desirable. This required only about five years, which is a short time in plant breeding. But just when the growers were feeling that the loss of the industry had been prevented, another disease, powdery mildew, became epidemic and the new brown blight resistant strains were destroyed as readily as the old strains. Fortunately, the scientists had at the same time been accumulating evidence relative to the breeding of lettuce so that in a relatively short time they were able to develop even better strains which were resistant not only to brown blight but to mildew as well. This well illustrates the constant fight necessary in coping with the changing conditions found in plant life, not only to discover ways and methods of producing new crops but to maintain the advances already made.

We hear much about the importance of vitamins in the diet, and children are provided with plenty of orange juice to build up their general health and resistance, especially in winter. The navel orange, which supplies much of this juice, was introduced from Brazil, and it is estimated that it has already been worth more than a billion dollars to orange growers. It is difficult to estimate what this introduction has been worth in improved conditions of health and nutrition of the American people, and the consequent betterment and rise in their standards of living.

Four centuries ago the tomato was unknown to civilized man, yet to-day it is one of the most widely grown and highly esteemed vegetables. The leading commercial variety in use now is the Marglobe, bred by a department worker. When the Marglobe was introduced in 1927 the tomato shipping industry in Florida was faced with ruin because of a combination of two diseases, Fusarium wilt and nailhead rust. The new variety was resistant to these diseases and is now grown practically throughout the eastern half of the United States. The existence of the tomato juice canning industry depends upon Marglobe and other improved varieties.

With reference to the principal crops which supply the great bulk of food for both human beings and animals, such as wheat, barley, corn and potatoes, similar improvements have been made with reference to improved quality and resistance to disease. The planting of hybrid corn, for instance, has increased from about 35,000 acres in 1933 to over 23,000,000 acres in 1939. The development, introduction and use of disease resistant varieties of oats, barley, wheat and other cereals have been big factors in helping to stabilize the production of these crops and in preventing the financial ruin of many families.

Sometimes a pest or disease doesn't make a frontal attack by killing plants outright or making the fruit unusable, but instead, gradually reduces the vigor and yield of the plant. In Georgia, peach trees for many years were affected by a form of eelworms or nematodes that causes swelling on the roots, commonly referred to as root-knot. Plant explorers and research men found the answer to this problem in the form of rootstocks that are resistant to nematodes. At least two resistant rootstocks have been developed. Within the next year or two peach growers in the South and Southwest should be able to buy nursery stock budded on these improved stocks.

Perhaps enough examples have been given to show how plant scientists are able to save crop industries and thus affect the incomes and welfare of large groups of people, and why continued research is necessary. In this constantly changing field, we have to move forward just to hold our ground.

Many of us have seen in our own generation some remarkable changes take place in the food habits of the American people. If we go back another generation or two the change is even more striking. We can recall the time when fresh fruits and vegetables were displayed at the corner grocery only when they were in season. Just try to contrast the grocery stores that we remember as children with those of to-day.

Many factors have played a part in bringing about a change in our diets. The great advances made in refrigerated transportation have certainly played an important role. New methods of growing plants and of feeding livestock, improvements in the manufacture and processing of food products and a desire to keep in step with current trends in our food selection have all helped. Perhaps the strongest urge has been provided by the new knowledge about nutrition, including the vitamins, minerals, trace elements and all the rest.

Changes have taken place in the American diet—desirable changes. But nutritional studies show that very large numbers of people in this country are still far from being well nourished.

This leads to the question, what may we as individuals expect from better diets? We know, of course, that through a proper diet many nutritional diseases may be prevented. We have no proof that diet gives actual immunity to infectious diseases, but there is no doubt about its value in promoting resistance against certain of them. Experiments at Columbia University with rats indicate that diet has a decided effect on length of life. Similar experiments at Johns Hopkins and elsewhere indicate that diet affects vigor and well-being at all ages and that it is possible by diet to postpone the usual signs of senility.

Nutritionists and medical men have proved that there are immense possibilities for building a more robust citizenship in this country through improved

trition. This means, of course, an attack on both verty and ignorance. An astonishing number of eople can afford good diets but don't know how to t them. Can plant science contribute to the goal better bodies through better nutrition? My answer an emphatic "yes."

Some of the means through which this can be and s already been accomplished have been mentioned. ew crop plants have been introduced, better varies developed and cultural and harvesting methods so nproved that many commodities, among them dates, gs, broccoli, avocados, pecans, spinach, lemons and lmonds, are no longer rarities or beyond the means f the average man but have come to form a definite art of the daily diet. Similarly, the great staple rops such as corn, wheat, oats and potatoes have een so improved in quality, disease resistance and daptation to production over great areas of variable oil and climate that they are more readily available nd better adapted than ever for human food and as eed for domesticated animals.

Research can not stop here, however. There is still widening and increasing need for further investigaions which must deal extensively and intensively with roblems of further improvement of quality in plants nd with their nutritional values. About a year ago I resented a paper before the American Association or the Advancement of Science at Richmond, Virginia,[2] in which I went into some detail concerning he interrelation of soils and plant, animal and human utrition. It seemed to me at the time that recent development in the field of nutrition of both plants nd animals were opening up vistas of a whole new ield of agricultural research.

The point I made then was that the principal objective of many of our plant investigations for some ime past has been to adjust soil management practices, change environmental conditions and in many cases modify the above-ground portions of the plant in order to obtain as *large* crop yield as possible; but that recent developments in the science of nutrition suggest that we ought to devote more attention to producing crops of the highest *nutritional* quality for man and animals. I stated: "Obviously here is a case where an interrelationship must be studied—the interrelationship between the physical well-being of man and the factors in the soil that affect the composition and development of plants."

For example, some soils in this country are deficient in certain minerals essential for health while other soils contain large amounts of minerals detrimental to health. It is evident that groups of people, dependent for food upon the plants grown in certain areas or upon animal products produced in such areas, will have food that will be deficient in certain beneficial elements or contain excesses of detrimental ones. There are many examples of the occurrence of physiological diseases of both plants and animals in various areas. Dr. Ouida Davis Abbott of the Florida Agricultural Experiment Station recently told members of the American Institute of Nutrition that farm children in Florida and other regions as well are in danger of severe nutritional anemia if they live on home-grown food from soil that is deficient in iron. She stated that the anemia is not primarily due to hookworm as previously believed; that although hookworm infection affects the degree of anemia, the prevalence of anemia among the rural children is due primarily to diets low in iron. Anemia was discovered in 52 to 96 per cent. of rural children living in regions where the soil was predominately deficient, as shown by the prevalence of "salt sickness" of cattle.

Thorough scientific investigations should be conducted to determine the effects of the various elements upon the growth of plants and of the animals consuming such plants. After surveys and investigations, certain soil areas found undesirable for the production of food might be converted into forests, parks and recreational centers, or used for the production of crops for certain industrial uses as one of the phases of land use adjustment, while other soil areas found deficient in certain desirable food elements might be improved through the addition of the necessary elements in a routine way through fertilizers, irrigation water or sprays applied to the plants. By such means people dependent upon the crops in their own areas would automatically and perhaps unknowingly in most cases have food of high nutritional quality. Such foods shipped into other areas would be equally valuable to consumers everywhere.

National Attack on Nutrition Problem

A national attack on this problem is now being made. Funds have been made available to the government and states for fundamental basic research in relation to agriculture under the Bankhead-Jones Act. Part of these funds were made available for the establishment of special regional laboratories. These laboratories cover such research projects as the breeding and improvement of vegetables; pasture improvement studies; effects of the salinity of irrigation water upon plant growth and the physical composition of the soil; poultry and animal diseases; soybean utilization, etc.

The laboratory most recently established deals with the problem which I have just been discussing. This laboratory in cooperation with various state agricultural experiment stations and other research institutions is located at Cornell University, Ithaca, New

[2] E. C. Auchter, Science, 89: 421–427, May 12, 1939.

York, and is national in scope. Buildings and greenhouses have been erected and a staff trained in all of these fields has been secured to attack this whole problem of the interrelation of soils and plant, animal and human nutrition. A national advisory council of specialists in the problems of nutrition, geneticists, agronomists, plant physiologists, animal physiologists, horticulturists, soil scientists, botanists, members of the U. S. Public Health Service and medical men, has been formed.

Information regarding some of the soils of the United States with particular reference to their origin, chemical and physical composition, amenability to various treatments and effectiveness in producing plants, is available. An attempt will be made to correlate the composition and nutritional value of foods with soil type, climatic conditions and the practices followed in production. One of the great needs appears to be that of making more comprehensive studies and complete analysis of agricultural soil types and areas and the variety and stage of maturity of crops that grow upon them under known conditions of climate, fertilization and irrigation. Such information would enable us to determine if deficiencies or excesses of certain elements occur in such soils and plants and, if so, to correct the conditions with the ultimate view of improving the health of human beings.

Concurrently, a survey will be made to determine the occurrence of the various elements in fertilizer materials, sprays, dusts and the like and whether such substances may definitely modify the composition of plants and thus make them more nutritious or less nutritious or even toxic to man and animals. Special attention will be given to the physiological effects of the so-called rare or trace elements.

Little is known in detail of the functions of most of the trace elements. Some of them may have subtle and far-reaching effects. Investigations should be made, therefore, of the nature or availability of the compounds occurring in soils and how they are affected by chemical and biological processes in the soil. Studies of the periodicity of the intake or distribution of the elements within the plant and of the differences among species of plants or among strains within a species in their need for mineral elements and their ability to accumulate them should also be made. And in addition, the effects of chemical additions to the soil upon the composition of the plant at various stages of growth will be determined.

Thorough physiological and anatomical studies are to be conducted on plants with reference to the availability, absorption, accumulation and effects upon growth of the various mineral elements—especially the minor elements—including their effect on the elaboration of vitamins, hormones and other compounds. This will involve both field and pot culture studies under carefully controlled conditions, and the further development of special techniques in handling such cultures and of improved analytical methods for the detection of minute quantities of the elements under study.

Consideration should also be given to the digestibility and utilization in the body of the various plant compounds in relation to other factors affecting metabolism and growth. Plants produced in controlled experiments or in various soil areas will be fed to the usual laboratory test animals in order to determine how their rate of development, general health and behavior are affected.

The effects of plants of known composition on human beings will also be determined. There will be wide studies of the adequacy of the various mineral elements and growth substances in the diets of various population groups, especially those dependent upon locally produced food products. It may be found desirable to conduct breeding investigations for the purpose of developing special strains or varieties of plants in relation to nutritional value. Despite the fact that we have certain genetic strains, the manner in which they are grown may modify their nutritional quality.

Although the problems concerned in such investigations are extremely complex and will require considerable time and funds for their solution, still their great importance in our national life justifies and, in fact, demands that such studies be made. We know that raising the level of health of the population is important in all phases of our national life.

This brief outline of the beginning of a comprehensive line of investigation is an example of the many new problems which are constantly arising and which require for their solution the cooperation of the best scientists in many fields. I feel sure that with the cooperation of the agricultural experiment stations, universities, research institutions and private individuals, this and many other problems will be solved.

CONCLUSION

Now, in conclusion, let me go back for a moment to my original theme at the beginning of this paper. You will remember that I said science was responsible for the development of our modern civilization; and I was not modest about attributing much of this civilization to the development of scientific methods in agriculture. But this is not enough; we can't rest on our oars. Two other things are necessary. First, in order to *maintain* what we have, we must keep constantly on the job with the kind of research I mentioned in connection with plant diseases. You might

call this *defensive* research; it is the method by which we defend ourselves against a host of hostile forces. Second, we have to have another even more far-reaching kind of research that looks to the future. You might call this *aggressive* research. Certainly we are not entirely satisfied with the civilization we have to-day. We want to go forward, to build a still better civilization. And as science made our present civilization possible, I believe it will also make possible the better civilization of the future if we keep on with *aggressive* research in all the sciences, natural and social.

OBITUARY

WAYNE J. ATWELL

IN the untimely death of Dr. Wayne J. Atwell on March 27, the University of Buffalo has lost one of its most valued teachers and administrators, and the world of science has been deprived of one of its ablest and most energetic investigators.

Wayne J. Atwell was born in Fairfield, Nebraska, in 1889. After graduation from Nebraska Wesleyan University in 1911, he entered the University of Michigan as a medical student. Becoming interested in the morphological sciences, he discontinued the study of medicine, and under the inspiration and guidance of the late Dr. G. Carl Huber, began his career as a teacher and investigator. He was granted the degrees of A.M. and Ph.D. by the University of Michigan in 1915 and 1917, and served as assistant or instructor in the anatomy department of that institution until he was appointed professor and head of the department of anatomy of the University of Buffalo in 1918. In the latter institution, after several years spent in building up his department and its staff, he was able to continue his medical studies on a part-time basis, and was awarded the degree of doctor of medicine in 1934.

Dr. Atwell's first contribution to the literature of science was a paper on the relation of the notochord to the hypophysis, published in the *Anatomical Record* in 1915. In the same issue of the *Record* he published a shorter article describing the conversion of a photograph into a line drawing.

During his graduate study under Dr. Huber he acquired skill in a variety of techniques and procedures which were of value in his later investigations, the results of which were usually elucidated in his papers by excellent drawings of sections, models or reconstructions, or by skilled photography. His thorough and critical study of the development of the hypophysis of the rabbit, on which he prepared his doctor's dissertation, fixed his interest in the morphology and function of that organ and determined the trend of his later research. The morphology of the organ, sometimes with particular reference to its pars tuberalis, was treated in a series of papers on its embryology in the tailed amphibia, in man, and in the chick; his last completed scientific paper, which appeared during the month of his death, dealt with the morphology of the hypophysis in several species of toads. These various embryological and anatomical studies were supplemented by an investigation of the histology of the pars tuberalis, and a study of the Golgi apparatus in the cells of the anterior lobe.

The numerous morphological studies mentioned above naturally led to an interest in the functions of the several parts of the hypophysis and stimulated the experimental work which constitutes much of Dr. Atwell's later contribution to our knowledge of the organ. Beginning in 1919 with a short report in SCIENCE, he published a number of papers dealing with the relation of the pituitary to pigmentary changes in the amphibia, and the nature of the pigmentary responses in these animals; his latest investigation in this field was to have been presented before the American Association of Anatomists at its April meetings in Chicago. He also investigated by experimental methods the thyreotropic and adrenotropic hormones of the anterior lobe, as well as certain pituitary-adrenal-gonad relationships; and he attempted through the use of extracts prepared from it, to determine the functional role of the pars tuberalis. He developed methods of transplantation of the pituitary anlage in amphibia and utilized hypophysectomy with and without such transplantation in several of his more recent studies. All in all, he played a highly important part in the establishment of our present concepts of pituitary structure and function.

In addition to his many papers on the hypophysis, Dr. Atwell reported (or aided his students to report) certain of the more rare anatomical anomalies encountered in the dissecting room. His outstanding work outside the field of his pituitary investigations, however, is his painstaking study of an early human embryo, published in the Carnegie Contributions to Embryology in 1930. This embryo has since been mentioned and figured in text-books of embryology as the Atwell embryo.

At various times Dr. Atwell served on the staff of *Biological Abstracts, Endocrinology* and *The American Journal of Anatomy.* He also served as president of the Western New York Branch of the Society for Experimental Biology and Medicine and as a mem-

ber of the Executive Committee of the American Association of Anatomists. That his various contributions to science were highly regarded by his fellow anatomists is evidenced by the fact that he was recently chosen as one of the ten anatomists to be added to the "starred" group in "American Men of Science."

Dr. Atwell's work as a teacher and administrator at the University of Buffalo made him one of the most admired, respected and beloved members of its faculty. As a teacher he had few equals; as an administrator he displayed rare tact and skill; and as a friend and counselor he won the regard and affection of his students and colleagues alike. His home, with Mrs. Atwell as a charming and gracious hostess, was often the scene of friendly informal social gatherings of his departmental staff or other faculty colleagues. His enthusiasm for and enjoyment of the out-of-doors will long be recalled by his fortunate companions on picnics, collecting jaunts, and canoeing and camping trips. In the several honorary and social fraternities of which he was a valued member, in his church, to which he gave freely of his time and efforts, and in the suburban community in which he lived, his loss will be keenly felt. His own life was rich in accomplishment and made happy by a wide variety of interests, and he left an inestimable number of others the richer for his association with them as teacher and friend.

R. R. HUMPHREY

UNIVERSITY OF BUFFALO

RECENT DEATHS

DR. OTIS ELLIS HOVEY, consulting civil engineer of New York City, died on April 15 at the age of seventy-seven years.

DR. CHARLES RUSS RICHARDS, president emeritus of Lehigh University, previously dean of the College of Engineering of the University of Illinois, died on April 17. He was seventy years old.

DR. FRED KUHLMANN, chief of the Division of Research of the Minnesota State Department of Public Institutions, died on April 19 at the age of sixty-five years.

Nature announces the following deaths: Dr. C. R. M. F. Cruttwell, formerly principal of Hertford College, Oxford, on March 17, aged fifty-three years; J. P. Gilmour, from 1916 to 1933 editor of the *Pharmaceutical Journal*, on March 10, aged eighty years, and E. L. Ince, lecturer in technical mathematics at the University of Edinburgh, on March 16, aged forty-nine years.

SCIENTIFIC EVENTS

THE PERMANENT SCIENCE FUND OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

INCOME from the Permanent Science Fund, according to agreement and declaration of trust, shall be applied by the American Academy of Arts and Sciences to such scientific research as shall be selected. Applications for grants under this trust are considered by the committee of the academy on stated dates. To be considered at the next meeting of the committee, applications must be in the hands of the chairman of the committee, Professor John W. M. Bunker, Massachusetts Institute of Technology, Cambridge, Mass., on or before October 1.

Grants in aid from this fund were authorized by the academy on March 12, 1941, as follows:

Robert B. Dean, junior instructor, University of Minnesota, for the study of bimolecular films, $200.

Dr. Nicholas T. Werthessen, Endocrine Laboratory, Boston Dispensary, for assistance in the study of ovarian disfunctions, $720.

Graham P. DuShane, instructor in zoology, University of Chicago, for assistance in the investigation of reflexes through isolated motor cells, $400.

Donald D. Brand, professor of anthropo-geography, University of New Mexico, for materials and field expenses of an archeologic study of the occupation sequence in the middle Rio Balsas area, Guerrero and Michoacan, Mexico, $405.

Charles B. Davenport, retired, of the Carnegie Institution of Washington at Cold Spring Harbor, for assistance in completing the analysis of certain biometrical studies on children, $200.

Joseph S. Butts, professor of biochemistry, Oregon State College, for expendable materials and for assistance in continuing his study of the Intermediary Metabolism of Amino Acids, $350.

Paul A. Vestal, research curator, Botanical Museum, Harvard University, for expendable materials, assistance, and certain field expenses, in connection with an ethnologic study in the economic botany of the Ramah-Atarque Navaho Indians, $300.

George W. Kidder, assistant professor of biology, Brown University, for assistance in studies of substances produced by living cells which accelerate or inhibit the proliferation of other cells, $450.

Barry Commoner, tutor, department of biology, Queens College, Flushing, N. Y., for equipment to permit continuation of a biochemical investigation of the relation between auxin, respiratory mechanisms and growth in plant cells, $350.

Vincent G. Dethier, instructor in biology, John Carroll University, Cleveland, Ohio, toward expenses of a study of the chemistry of food plants chosen by larvae of certain species of Chrysophanus in North America, $200.

Margaret Harwood, director, Maria Mitchell Observatory, Nantucket, Mass., for assistance in a study of the form and motions of Eros, $400.

Frederick Johnson, curator, Robert S. Peabody Founda-

tion for Archeology, Andover, Mass., toward the cost of publication of the data from collaborative studies upon the Boylston Street Fishwier [the remainder of the cost having been secured elsewhere], $300.

Philip M. Morse and Julius A. Stratton, professor and associate professor of physics, respectively, the Massachusetts Institute of Technology, for assistance in completing the calculation of tables of functions involved in the theory of wave radiation and scattering, $450.

Leigh Hoadley, professor of zoology, Harvard University, for assistance in the study of nerve processes arising from isolated portions of the embryonic brain, and the differentiated tissues into which the processes lead, $150.

ALUMNI LECTURES AT THE UNIVERSITY OF CINCINNATI

DR. A. J. CARLSON, of the University of Chicago, in his excellent address "Science *versus* Life," the nineteenth annual Sigma Xi lecture in Philadelphia on December 30 last,[1] mentions that the universities are quite generally lax in arranging for advanced science lectures to be offered to their graduates in "Alumni Go Back to College" courses. The department of chemical engineering of the University of Cincinnati is at least one faculty which has arranged for a series of free talks, "Recent Trends in Chemical Engineering," to be given at monthly intervals, only to their alumni. Half the evenings are devoted to lectures by the faculty, the others by their own alumni who have become distinguished in some field of chemical engineering.

"Industrial Bacteriology," October 16, Dr. H. S. Greene, associate professor of chemical engineering, University of Cincinnati.

"Food Technology," November 14: (a) "Evolution of the Modern Bake Oven," Michael J. Colacurcio, assistant superintendent, Strietman Biscuit Co., Cincinnati. (b) "Some Phases," George Garnatz, chief of staff, Kroger Food Foundation, Cincinnati.

"Physical Chemistry," December 9, Dr. E. F. Farnau, professor of physical chemistry, University of Cincinnati.

"Industrial Colloids," January 16: (a) "Synthetic Sudsing, Detergent and Wetting Agents," W. F. Schanzle, Procter and Gamble, Cincinnati. (b) "Glues," Clark B. Rose, plant engineer and director of research, Chemical Products Corporation, Cincinnati. (c) "Rubber Technology," Joseph Rochoff, head of laboratories, Dayton Rubber Manufacturing Company, Dayton.

"Metallurgy," February 26, Dr. R. O. McDuffie, associate professor of metallurgy, University of Cincinnati.

"Paper Technology," March 18: (a) "Technical Development of Coated Paper," Alex J. Wildman, research engineer, Champion Paper and Fibre Company, Hamilton, Ohio. (b) "Twenty Years of Progress in the Technology of Uncoated Paper," Daniel Fuentes, control chemist, Champion Paper and Fibre Company.

An inexpensive dinner get-together precedes each talk. This year, the first in which the plan was adopted, practically 30 per cent. of the alumni within twenty-five miles of Cincinnati attended the talks which have been given so far. So much enthusiasm has been aroused that a similar series of lectures is already planned for next year. The advantages to both the alumni and faculty are so obvious that they need not be stated.

S. B. ARENSON

[1] Printed in winter, 1940, issue of the Sigma Xi quarterly.

AWARDS IN THE WILLIAM LOWELL PUTNAM MATHEMATICAL COMPETITION

PROFESSOR W. D. CAIRNS, secretary-treasurer of the Mathematical Association of America, has announced that the department of mathematics of Brooklyn College has won the first prize of $500 in the fourth annual William Lowell Putnam Mathematical Competition. The members of the winning team were Richard Bellman, Peter Chiarulli, Hyman Zimmerberg. The second prize of $300 is awarded to the department of mathematics of the University of Pennsylvania, the members of whose team were S. I. Askovitz, Hyman Kamel, P. C. Rosenbloom. The third prize of $200 is awarded to the department of mathematics of the Massachusetts Institute of Technology, the members of the team being J. R. R. Baumberger, Eugene Calabi, W. S. Loud.

In addition to these prizes to the departments of mathematics with winning teams, a prize of $50 each is awarded to the following five persons whose scores ranked highest in the six-hour examination (the names are arranged in alphabetical order): R. F. Arens, University of California at Los Angeles; S. I. Askovitz, University of Pennsylvania; A. M. Gleason, Yale University; E. L. Kaplan, Carnegie Institute of Technology; P. C. Rosenbloom, University of Pennsylvania. Of these five, one will later be chosen to receive a $1,000 graduate scholarship for one year at Harvard University. This award will be announced later. The members of the three winning teams will receive individual cash prizes according to the ranks of their teams, and all individuals receiving prizes will also receive medals.

Honorable mention has been awarded this year to three teams and to six individuals. The teams are from the Department of Mathematics, Carnegie Institute of Technology, Pittsburgh, members being R. E. Beatty, E. L. Kaplan, N. H. Painter; the Department of Mathematics, Cooper Union Institute of Technology, New York, members being Murray Klamkin, Benjamin Lax, Samuel Manson; and the Department of Mathematics, Yale University, New Haven, mem-

bers of the team being A. M. Gleason, G. R. MacLane, D. M. Merrill. The six individuals receiving honorable mention are: Richard Bellman, Brooklyn College; Harvey Cohn, College of the City of New York; W. S. Loud, Massachusetts Institute of Technology; G. R. MacLane, Yale University; Samuel Manson, Cooper Union Institute of Technology; Hyman Zimmerberg, Brooklyn College.

The fourth annual William Lowell Putnam Mathematical Competition was held on March 1. One hundred and forty-six undergraduate mathematics students from 44 colleges and universities in the United States and Canada took part. Qualified readers graded the examination books, complete anonymity being maintained throughout by the use of numbers instead of names for identification.

The first competition was held in April, 1938, the second in March, 1939, the third in March, 1940. This competition was designed to stimulate a healthy rivalry in the undergraduate work of departments of mathematics in colleges and universities in the United States and Canada, and is open only to undergraduates. The examination questions are taken from the fields of calculus, higher algebra, differential equations and geometry.

The Putnam Competition is made possible by the trustees of the William Lowell Putnam Intercollegiate Memorial Fund, left by Mrs. Putnam in memory of her husband, a member of the Harvard class of 1882, and is sponsored by the Mathematical Association of America.

ADMISSIONS TO THE FELLOWSHIP OF THE ROYAL SOCIETY

THE following were elected on March 20 fellows of the Royal Society, London:

W. N. BENSON, professor of geology, University of Otago, Dunedin, New Zealand; distinguished for his contributions to the geology, petrology and physiography of Australia and New Zealand and in particular for his studies on the ultra-basic igneous rocks.

H. J. BHABHA, reader in theoretical physics, Indian Institute of Science, Bangalore; distinguished for his contributions to the understanding of cosmic ray phenomena and to the fundamental theory of the elementary atomic particles.

E. C. BULLARD, Smithson research fellow of the Royal Society; distinguished for his work in geophysics and for the light which his work has thrown on the structure of the Great Rift Valley and on the rock floor deep under the surface in England and the surrounding seas.

C. D. DARLINGTON, director of the John Innes Horticultural Institution; distinguished for his researches in cytology and cytogenetics.

P. I. DEE, university lecturer in physics, Cambridge; distinguished for his experimental work in nuclear physics, in particular on atomic nuclear transformations produced artificially under bombardment by high speed protons or deuterons.

S. F. DUDLEY, Surgeon Rear-Admiral, medical director-general of the Navy (designated); medical officer in charge R.N. Hospital, Chatham; formerly deputy medical director-general R.N.; distinguished for his work in epidemiology and bacteriology, especially in relation to the spread of diphtheria, influenza and meningitis.

J. C. ECCLES, director of the Kanematsu Memorial Institute for Pathology in Sydney, formerly Rhodes Scholar (Australia) and fellow of Magdalen College, Oxford; distinguished for his physiological researches which have dealt principally with excitation and transmission in the neuromuscular system.

H. W. FLOREY, professor of pathology in the University of Oxford, formerly Rhodes Scholar (Australia), fellow of Gonville and Caius College, Cambridge, and professor of pathology, Sheffield; distinguished for his work in general pathology, in particular on lacteals and lymphatics and on Brunner's glands. His work on "lysozyme" has led to its isolation in a pure form.

A. A. GRIFFITH, research engineer, Rolls Royce, Ltd., formerly Royal Aircraft Establishment, Farnborough; distinguished for researches, ranging from pure physics to applied engineering, which have made notable contributions to the knowledge of strength of materials and to the science and development of aircraft and aero-engines.

H. W. MELVILLE, professor of chemistry in the University of Aberdeen, formerly fellow of Trinity College, Cambridge; distinguished for his outstanding contributions in the study of gaseous reactions and of the mechanism of polymerisation.

J. NEEDHAM, reader in biochemistry in the University of Cambridge, and fellow of Gonville and Caius College; distinguished for his application of biochemical methods to embryology, particularly in relation to the conditions determining embryonic and adult metabolism, and vertebrate development.

SIR DAVID RIVETT, deputy chairman and chief executive officer of the Australian Council for Scientific and Industrial Research, formerly Rhodes Scholar (Australia) and professor of chemistry in the University of Melbourne. His scientific knowledge and leadership have been of great value to the Australian Commonwealth and the Empire.

ALEXANDER ROBERTSON, professor of organic chemistry in the University of Liverpool; distinguished for his researches on the constitution of plant products, and particularly on the important insecticide rotenone.

T. G. ROOM, professor of mathematics in the University of Sydney; distinguished for his work in geometry.

A. J. ROWLEDGE, mechanical engineer, chief designer, Rolls Royce, Ltd., formerly chief designer, D. Napier and Sons, Ltd.; distinguished for innovations in the design and development of internal combustion engines for motor vehicles and aircraft.

H. SCOTT, assistant keeper of entomology in the British Museum (Natural History); distinguished as a field naturalist and systematist. By prolonged visits to the Seychelles, Abyssinia and South Arabia he has greatly advanced our knowledge of the little known and fast disappearing or changing fauna of these areas.

F. E. SIMON, reader in thermodynamics in the University of Oxford; distinguished for the development of new methods of liquefying helium and for his studies of phenomena at the lowest temperatures yet attained.

H. G. THORNTON, head of the bacteriology department, Rothamsted Experimental Station; distinguished for his investigations in soil bacteriology and on the relations existing between nodule-forming bacteria and their leguminous hosts.

R. A. WATSON WATT, scientific adviser on telecommunications, Ministry of Aircraft Production, formerly superintendent, Radio Department, National Physical Laboratory; distinguished for his contributions to radio engineering, particularly in relation to aerial and marine navigation.

P. BRUCE WHITE, member of the scientific staff of the National Institute for Medical Research, Hampstead; distinguished for his fundamental studies of bacterial immunology, in particular of the antigenic constituents of members of the *Salmonella* group.

SCIENTIFIC NOTES AND NEWS

DR. JAMES BRYANT CONANT, president of Harvard University, returned on April 15 after two months in England as head of the mission sent by President Roosevelt to make "first-hand observations of recent English scientific research and experience." While in England, he received the degree of doctor of science from the University of Oxford and was entertained at a luncheon given at Burlington House by the president and fellows of the Royal Society.

LAZARUS WHITE, president of Spencer, White and Prentis, construction engineers of New York City, was presented with the 1941 Egleston Medal of the Columbia University Engineering Alumni Association at the seventieth annual dinner of the association held on April 17 at the Columbia University Club. The medal, "for distinguished engineering achievement," was presented by Felix E. Wormser, president of the association.

WILLIAM LOREN BATT, Philadelphia engineer, has been presented with the 1940 Henry Laurence Gantt Memorial Gold Medal for "distinguished and liberal-minded leadership in the art, science and philosophy of industrial management in both private and public affairs." The presentation was made at a dinner of the American Society of Mechanical Engineers, which was held on April 22 at the Engineers' Club of Philadelphia in conjunction with the two-day Management Conference on National Defense, sponsored jointly by the Management Division and the Philadelphia Section of the society. Dr. L. P. Alford, chairman of the Gantt Medal Board of Award, introduced Mr. Batt, and Dr. William A. Hanley, president of the American Society of Mechanical Engineers, made the presentation.

WASHINGTON UNIVERSITY, St. Louis, at a special convocation on April 9, commemorating the seventy-fifth anniversary of its Dental School, conferred the doctorate of science on Brigadier General L. C. Fairbank, Dental Corps, U. S. Army; Dr. Hermann Prinz, professor of materia medica and therapeutics, School of Dentistry, University of Pennsylvania; Dr. Isaac Schour, College of Dentistry, University of Illinois; Dr. Philip Jay, School of Dentistry of the University of Michigan; Dr. Paul C. Kitchin, College of Dentistry of the Ohio State University; Dr. Alfred P. Rogers, Dental School, Harvard University, and Dr. Raymond C. Willett, of Peoria, Ill.

RAYMOND R. RIDGWAY, Niagara Falls, N. Y., has been elected president of the Electrochemical Society. The society has awarded the thirteenth Weston Fellowship of $1,000 to Rodney E. Black, of Pawhuska, Okla., who is investigating the plating of molybdenum and tungsten alloys at the University of Wisconsin.

PROFESSOR GARDNER MURPHY, chairman of the department of psychology at the College of the City of New York, was elected president of the Eastern Psychological Association at the recent annual meeting held at Brooklyn College on April 18 and 19. He succeeds Dr. Walter S. Hunter, of Brown University.

DR. NATHAN SMITH DAVIS, III, was reelected president of the Chicago Academy of Sciences at the eighty-fourth annual meeting on April 14. Other officers were elected as follows: Tappan Gregory, *first vice-president;* Dr. Verne O. Graham, *second vice-president,* and Alton S. Windsor, *secretary.* John Nash Ott, Jr., was elected a *member of the Board of Trustees;* Dr. Charles A. Shull, of the University of Chicago, and Dr. L. Hanford Tiffany, of Northwestern University, were elected to the *Board of Scientific Governors.* The speaker of the evening, Dr. A. C. Ivy, professor of physiology and pharmacology at Northwestern University Medical School, was elected an honorary member of the academy. Dr. Ivy's address was entitled, "The Gastrointestinal Hormones and Their Uses."

OFFICERS of the Wildlife Society elected for 1941 are: *President,* Richard Gerstell, chief of the Division of Propagation and Research of the Pennsylvania Game Commission, Harrisburg; *Vice-president,* Walter P. Taylor, leader of the Texas Cooperative Wildlife Research Unit, College Station, Texas; *Treasurer,* Lee E. Yeager, of the Illinois Natural History Survey, and *Secretary* (reelected), Frank C. Edminster, chief

of the Regional Biology Division of the Soil Conservation Service, Upper Darby, Pa.

AT a recent meeting of the Vermont Club of the Society of the Sigma Xi, Professor Paul A. Moody, of the department of zoology of the University of Vermont, was elected president; Professor H. B. Pierce, of the department of biochemistry of the College of Medicine, was elected vice-president, and Professor H. G. Millington, of the College of Engineering, secretary-treasurer.

THE centenary of the Chemical Society, London, occurred on March 30. The hundredth annual general meeting was held on April 3, when Professor J. C. Philip was elected president. The address of Sir Robert Robinson, the retiring president, was on the mechanism of the benzidine rearrangement.

DR. ALEXANDER KLEMIN has been appointed Guggenheim research professor of aeronautics at New York University, and Charles H. Colvin, acting chief of the instruments division of the U. S. Weather Bureau, director of the Daniel Guggenheim School of Aeronautics in the College of Engineering. Dr. Klemin, who has been in charge of the Guggenheim School since its founding in 1925, was appointed to the newly established professorship at his own request so that he might devote his time to research and teaching rather than to administrative affairs. He will direct research in aeronautics in the fields of theoretical analysis and synthesis.

DR. ELLEN C. POTTER, medical director of the New Jersey Department of Institutions and formerly Pennsylvania State Secretary of Welfare, has been elected to succeed Dr. Chevalier Jackson as president of the Woman's Medical College of Pennsylvania.

DR. LEE R. DICE, director of the Laboratory of Vertebrate Genetics of the University of Michigan, has been made head of the newly established department of human heredity. This department will conduct in the University Hospital a clinic on heredity, the first to be established in America.

IN the issue of April 11 Dr. Charles H. Behre, Jr., is referred to as chairman of the department of geology and geography of Northwestern University. Professor J. T. Stark succeeded him as chairman in 1937.

DR. J. M. YOFFEY, lecturer in anatomy at the University College of South Wales and Monmouthshire, has been appointed to the chair of anatomy in the University of Bristol in succession to Professor S. E. Whitnall, who retires at the end of the current session.

DR. J. H. GRAY, since 1937 senior demonstrator in anatomy at University College, London, has been appointed, from May 1, to the chair of anatomy tenable at St. Mary's Hospital Medical School at the University of London.

DR. ROBERT E. DOHERTY, president and previously dean of the School of Engineering of the Carnegie Institute of Technology, has assumed office as chairman of the Production Planning Board of the Office of Production Management of which he has been a member, to succeed Samuel R. Fuller, Jr., who recently has been made chief of the Materials Branch of the Office of Production Management.

THE *News Edition* of the American Chemical Society states that Dr. Ralph H. Manley has resigned his position as assistant director of the Armour Research Foundation, Chicago, to become senior chemist in the oil and protein division at the Northern Regional Research Laboratory of the Department of Agriculture at Peoria, Ill.

J. ROBERT COFFMAN, research associate in biochemistry at the University of Chicago, has joined the staff of the Division of Chemistry of the Armour Research Foundation at Chicago, to conduct research on industrial utilization of grain proteins.

ACCORDING to *Popular Astronomy,* Dr. Y. C. Chang, who took his doctor's degree at the University of Chicago in 1929 for work done at the Yerkes Observatory, has been appointed director of the Institute of Astronomy, Academia Sinica, Kunming (Yunnan), China, to succeed Dr. C. S. Yu.

DR. ALBERT W. C. T. HERRE, of the Museum of Natural History of Stanford University, has returned after an absence of eleven months spent in studying the fisheries and collecting cold-blooded vertebrates in the Philippines, Malaya and India.

DR. GEORGE W. CORNER, director of the department of embryology of the Carnegie Institution of Washington, returned to his laboratory in Baltimore on April 7 from South America. Besides participating in the Second Pan-American Congress of Endocrinology, held at Montevideo, Uruguay, from March 5 to 8, he lectured at Montevideo; at Buenos Aires, Rosario and Cordoba, Argentina, and at São Paulo, Brazil.

THE Rice Institute lectures of Professor Edwin G. Conklin, of Princeton University, originally scheduled for March 5, 6 and 7, will be delivered on May 6, 7 and 8, under the auspices of the Sharp Foundation of the institute. Dr. Conklin's general subject is "What is Man?" and the subjects of the several lectures are "The Human Species," "The Development of the Individual" and "The Real and the Ideal."

DR. PERRIN H. LONG, of the Johns Hopkins University, delivered on March 29 a lecture before the Utah Chapter of the Sigma Xi on "Recent Advances

in Bacterial Chemotherapy with Special Reference to the Mode of Action of Sulfanilamide and Its Derivatives." This was the fourth in a series of lectures delivered before the Utah Chapter during the present year. The other speakers and their subjects were: "Europe on the Nazi Forge," by Dr. Ralph V. Chamberlin, head of the department of biology of the University of Utah; "Significance of the Human Blood Groups," by Professor R. Ruggles Gates, of the University of London, and "Industrial Fatigue," by Dr. Winifred C. Cullis, professor of physiology, University of London.

Professor R. Ruggles Gates delivered a Schiff Foundation lecture at Cornell University on April 9, his subject being "Some Recent Aspects of Human Genetics." On April 10 he spoke before the seminar in cytology on "The Phylogenetic Significance of Satellite Chromosomes and Nucleoli."

Dr. Ernst Th. von Bruecke, formerly professor of physiology in the University of Innsbruck, was the guest of the University of Oregon during the week of April 4 to 11. He lectured before the Sigma Xi on "Fatigue and Recovery in Peripheral Nerves" and before the faculty on "Physiological Tendencies to Stabilize the Appearance of the Environment."

The position of assistant curator of mammals at a salary of $3,200 a year is open in the United States National Museum, a part of the Smithsonian Institution. The United States Civil Service Commission has announced an examination to fill this and other similar positions. Competitors will not have to take a written test but will be rated on their education and experience. Applications must be filed at the Washington office of the commission not later than May 14.

The American Association for the Study of Allergy will hold its annual meeting on June 2 and 3 at the Hotel Cleveland, Cleveland, Ohio.

The American Association of Museums meets at Columbus, Ohio, on May 15 and 16. There will be luncheons, an excursion and a full program. On the second day the meeting will be held at the Ohio State Museum, closing with the thirty-sixth annual dinner.

The New York Branch of the American Association of Scientific Workers will hold a symposium on "Scientific Method and Its Social Relations" on Wednesday, May 7, at 8 P.M., at Columbia University. The symposium will present the results of studies made by the committee on the social functions of science, of which Dr. Alexander Sandow, of New York University, is chairman.

The annual meeting of the North Eastern District of the American Institute of Electrical Engineers will be held at Rochester, N. Y., from April 30 to May 2, with headquarters at the Sagamore Hotel. There will be technical sessions, inspection trips, entertainment and special features. Four sessions will be devoted to the presentation of technical papers; the fifth session will include addresses by well-known speakers. In two other sessions, papers will be presented by students. An informal banquet will be held on the evening of May 1 at the Rochester Club. Addresses will be made by R. W. Sorensen, president of the institute, and Dr. Alan Valentine, president of the University of Rochester. Everett S. Lee, vice-president of the North Eastern District, will act as toastmaster.

The sixteenth annual meeting of the Eastern Section of the Seismological Society of America will be held jointly with the Section of Seismology of the American Geophysical Union on May 1 and 2. The session of May 1 will be in the National Academy and Research Council Building, Washington, D. C., and that of May 2 at Georgetown University. The program will include a symposium on "The Vertical Seismograph" and discussions of "The Strong Motion Work of the U. S. Coast and Geodetic Survey," "Local Earthquakes" and "Interpretation of Records of Earthquakes at Epicentral Distances of about Twenty Degrees." Further information may be obtained from the secretary, William A. Lynch, Fordham University.

The Conference on Methods in Philosophy and the Sciences will hold its regular spring symposium this year on Sunday, April 27, at the New School for Social Research, New York City. The subject of the conference will be "The Personal, Social and Scientific Significance of Differences in Philosophical Method." The participants include Professor Brand Blanshard, Swarthmore College; Professor Irwin Edman, Columbia University; Dr. Max Horkheimer, Institute of Social Research, and Professor Jacques Maritain, Paris Catholic Institute.

Ceremonies for the dedication of the new library building of the School of Medicine of Yale University will be held on the afternoon of Sunday, June 15. The exercises will take place in the building itself, with addresses by distinguished practitioners and scholars in medicine. The committee in charge of the dedication ceremonies consists of Dean Francis G. Blake; Dr. S. Bayne-Jones, formerly dean of the school; Dr. John F. Fulton, Sterling professor of physiology, and Dr. George H. Smith, research associate in anatomy. Funds for the construction of the new library were made available from the estate of John W. Sterling, graduate of Yale in the class of 1864. The building, constructed as an extension to the Sterling Hall of Medicine, is designed in the shape of a Y, with one wing devoted to the general medical library and one wing devoted to the historical library.

THE New York Academy of Sciences has announced prize contests for 1941. The A. Cressy Morrison Prizes in Natural Science of $200 each will be awarded to a member of the academy or one of the affiliated societies, for the two most acceptable papers in a field of science covered by the academy or an affiliated society. In accordance with the terms of a bequest made by the late George Frederick Kunz, the accumulated annual income of the sum of $1,000 is offered at intervals by the council of the academy for a paper by a member of the academy in the field of geology and mineralogy. The prize, amounting to $200, is now offered for the first time. These prizes will be presented at the annual dinner in December.

ACCORDING to the ***British Medical Journal*** the Rockefeller Foundation has agreed to continue until the end of 1941 its grant of £1,200 a year for research in cellular physiology at the Molteno Institute under the direction of Professor David Keilin, Quick professor of biology at the University of Cambridge.

DISCUSSION

PHYSICISTS NEEDED FOR NATIONAL DEFENSE WORK

MATHEMATICS, THE BOTTLENECK FOR PHYSICISTS

THE U. S. Civil Service Commission[1] recently called attention to the fact that we haven't in this country a sufficient number of trained physicists to carry on with our defense program and at the same time keep our educational institutions and industrial research laboratories going with proper personnel.

We are asking ourselves why more men are not going on into advanced work in physics after completing their college course. Many of our graduates are capable of doing advanced work if they cared to do so.

After 35 years of teaching I am personally convinced that the outstanding restraint to a larger election of physics as a life work is due to the fact that for the average undergraduate no practical and fruitful results follow from a study of mathematics and physics. Mathematics (the sine qua non for physics) and physics too are exacting beyond all compromise. "They involve a degree of coercion and constraint which is beyond the power of any teacher to fully mitigate," unless the student feels that he is getting something practical and worth while. If in the technique of mathematics and physics a student sees the tools wherewith he can tackle unknown problems (the research method[2]) he will go to any length to master the same. The subjects will then become challenging to an individual with red corpuscles and the intestinal stamina to work.

Let us examine this common ground between mathematics and physics and which will be presently true of chemistry and eventually of biology. In the teaching of first-year college physics I am confronted year after year with the inability of my students to do the simplest kinds of ordinary algebraic transformations. Ordinary proportions appear to them to have nothing to do with chemistry and physics. If shown the expression:

$$a : b = c : d$$

they would say it was a proportion and would say with a little prodding that

$$\frac{a}{a+b} = \frac{c}{c+d}$$

was a case of proportion transformed by composition. Suppose, however, we give these students the following problem:

Two spheres are charged with a combined charge of 15 esu. If the radii of the two spheres are 10 and 20 centimeters, respectively, what is the charge on each sphere when put to a common potential by touching one sphere to the other? If they have studied the basic equation for static electricity, $C = Q/V$, they would go so far as to say that at the common potential, V, the two spheres would have the relation:

$$V = \frac{Q_1}{C_1} = \frac{Q_2}{C_2}$$

and

$$\frac{Q_1}{Q_2} = \frac{C_1}{C_2}$$

or since the capacitance of a sphere is numerically equal to the radius of the sphere we may write

$$\frac{Q_1}{Q_2} = \frac{r_1}{r_2}.$$

There they would stick. They might suggest that they had two simultaneous equations:

$$\frac{Q_1}{Q_2} = \frac{1}{2}$$

and

$$Q_1 + Q_2 = 15$$

It would seldom occur to the average student of physics that

$$\frac{Q_1}{Q_1 + Q_2} = \frac{r_1}{r_1 + r_2} = \frac{10}{30} = \frac{Q_1}{15}$$

and, therefore, $Q_1 = 5$ esu, while $Q_2 = 10$ esu.

Students will tell you that

$$y = mx$$

is the equation for a straight line, but seldom can they tell you what sort of a curve the velocity of a falling body would give when plotted against time of falling, as in the equation, $v = at$.

[1] *Jour. Applied Physics*, 12: 127, 1941.

[2] S. R. Williams, *School Science and Mathematics*, 29: October, 1929.

In Boyle's law,

$$PV = \text{a constant},$$

at constant temperature. They hardly ever see that this equation has anything to do with

$$xy = \text{a constant},$$

an equation, about which they have learned a little in analytical geometry. One could go far afield in this branch of mathematics showing how little association there is between the mathematics a student has learned and the applications he wishes to make in studying physics, such as the plotting of curves and what they mean in the particular problem under consideration. Why does a physicist (at least one) prefer to plot pressures against the reciprocals of volumes in Boyle's law and not get an hyperbola, when students having been told that $PV = \text{a constant}$ is the equation of an hyperbola will insist that P plotted against $\frac{1}{V}$ will give an hyperbola? Examples are legions in which the physics student seems unable to apply his mathematics intelligently to physical problems.

What is the trouble? Here is a problem in which physicists and mathematicians should be greatly interested. So far as the usefulness of the mathematics is concerned one wonders if mathematics teachers do not take too much the attitude of the author of a book on quaternions who is reported to have said when finishing the manuscript—"There, thank God, that has no practical value."

Calculus was developed by a physicist (Newton) because he needed such a tool wherewith to describe the motion of a body whose velocity was continuously and uniformly changing. Vector analysis was developed in a similar fashion. It combines within itself most of the advantages of both quaternions and of Cartesian analysis. Both calculus and vector analysis are necessary (practical) tools and when mathematics is taught from the standpoint from which most of it was developed, mathematics will have come into its rightful heritage and serve once more its true worshippers.

If this be a tirade against mathematicians it applies equally well in principle to physicists. What's food for the goose is also food for the gander. Physicists have been teaching an emasculated subject, because they are not willing to make the subject-matter useful. We have tried to teach a parlor physics devoid of mathematics and practical applications, and the student has rightfully felt he was receiving only husks. As W. S. Franklin once wrote: "There are too many people who fancy they have an interest in the 'results' of science and who, poor fools, invest in Keeley Motors and Sea Gold Companies because, forsooth, the desired result is so clearly evident."[3]

Teachers of physics spend too much time in the classroom expanding, let us say, on the wonders of television and its sociological connotations. They wish to sugar-coat it also by its historical setting and its philosophical implications. The really important and fundamental things which lie back in a vacuum tube have been quite forgotten; a knowledge of which was won by the sweat of other men.

When an individual, whose chief research is with a microscope, wonders why he can't get the same magnifying power for his instrument which the makers have given to it, and can't understand why the tube length has anything to do with the question, the thoughtful reader must realize that some physics teacher failed in making a simple mathematical equation,

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f},$$

and its consequences clear in first-year physics. The physics of lenses was not taught so as to be useful to any one. A carpenter may possess a set of tools, but if he can't build a house, of what use are the tools?

A potential physiologist or chemist ought to know the simple equation for a Wheatstone bridge or a potentiometer and how to use both the equation and instrument conjointly.

Metrology, the science of measurement, whether in the biological or in the physical sciences, rests upon the fundamental units of length, mass and time, whose standards have been established and maintained by physicists.

When one brings together in one student a supposed knowledge of both mathematics and physics and that student finds in the end that he has not been taught how to apply that knowledge, the student has a just cause for not liking physics which rests so fundamentally on mathematics.

A few years ago I had occasion to observe American and German students working together in the laboratory. The first thing a German student did was to see how the experiment would look set up in mathematical form. If it looked hopeful he progressed to the experimental set-up.

This is a proper procedure. American students couldn't even set up the equations for the problem, much less solve them, and yet these students were supposed to be at the same stage in their educational program. There is something to be said for Prussian drill master procedure in teaching mathematics. Mathematics must become an integral part of those who use the subject as the multiplication table is for most of us. There should be constant drill in mathematical technique when it is taught and particularly in its applications. Look over the average mathemati-

[3] W. S. Franklin, "The Elements of Mechanics," p. 17, 1907. The Macmillan Company, New York.

cal text-book and note page after page of problems, all of which are to be worked out by a common formula; why not introduce a lot of simple problems to be found in both the biological and the physical sciences for a practical application as one drills in the mathematical technique?

In an article "Science is Mobilised for War," Sir William Bragg[4] says, "The rate at which some scientific war problems are being solved is almost incredible; more advance is being made in a year than in ten years of peace, I suppose because everybody is keyed up and throwing all his energy into the job in hand. One can not help thinking, 'Why not do the same in peace time?' If the same team work could be put into tackling disease, smoky and ugly cities, better use of the land, improvement of our industries, and so on, there is no doubt that problems which have been bogeys for generations would disappear in a few years."

This seems to the writer to be a clear statement that science progresses most rapidly when it is put to practical and definite ends. Unfortunate it is that science must be put to practical uses of war, for Sir William closes with this high aspiration; "Scientists are doing their best to help the country in wartime. You may imagine with what enthusiasm they would join in a similar nationwide effort in times of peace, and how much more congenial to them their share in it would be."

Long ago Bacon wrote, "We advise all men to think of the true ends of knowledge, and that they endeavor not after it for curiosity, contention, or the sake of despising others, nor yet for reputation or power or any other such inferior consideration, but solely for the occasion and uses of life." Can any one imagine any other basis upon which the study of physics can be justified than for the occasions and uses of life?

S. R. WILLIAMS

AMHERST COLLEGE

PETROGLYPHS AS CRITERIA FOR SLOPE STABILITY

NEAR the western end of the Finlay Mountains, in Hudspeth County, Texas, is a large Indian campsite remarkable for its petroglyphs. This site extends for 850 feet along the scarp-slope and base of a cuesta made of strata belonging to the Cox (Cretaceous) formation.

The slope on which the site is situated has an average inclination of 20°. It is developed across layers of shale and thin-bedded limestone. At the top is a cliff 30 feet high upheld by a massive stratum of sandstone. Joint blocks fallen from the cliff bestrew the slope below, covering perhaps 80 per cent. of its surface. The slope distance from the base of the cliff to the base of the slope is 450 feet.

Many of the joint blocks on the slope exceed 20 feet in length and 10 feet in width. They lie at all angles, forming natural shelters under their projecting margins. It is evident that retreat of the cliff has proceeded largely by the detachment of sandstone joint blocks, which have slid or rolled down the slope below. Looking at the boulder-covered slope, one gets the impression that this retreat must be proceeding rapidly at the present. That this is not true is indicated by the archeology of the site.

Petroglyphs are pecked into the face of the sandstone cliff, and, judging by the continuity of pictures, no part of the cliff has broken away since the drawings were made. Petroglyphs also occur on approximately 60 of the joint blocks on the slope. Many of the pictures on the joint blocks are of animals. These remain in upright positions to-day, showing that none of the blocks on which they occur has toppled or rotated perceptibly since the petroglyphs were made. Middens are found in shelters on the down-slope sides of many blocks bearing petroglyphs. Nowhere was a block found resting on top of one of these deposits; evidently the blocks have not shifted downslope by a measurable quantity since the middens were formed.

Pottery collected from middens adjacent to petroglyph-bearing blocks has been identified as El Paso Polychrome, Chupadero Black-on-white and Three Rivers Red-on-terracotta, a ceramic complex which is typical for the Pueblo sites in the area. The time range of these three wares has been determined on the basis of their presence as intrusives in Pueblo sites of northern New Mexico that have been dated by dendrochronology. The pottery complex at this site has been dated at 1200 to 1300 A.D. by H. P. Mera,[1] of the Laboratory of Anthropology, Santa Fe. The pottery and petroglyphs seem, for the most part, to be contemporaneous; the same types of pottery are associated with similar petroglyphs elsewhere in the area. This indicates that the joint blocks in the cliff and at least 60 large blocks on the twenty-degree slope have been in essentially their present positions for the past 600 or 700 years.

Study of petroglyphs in situations similar to those here described may lead to quantitative data on the stability of cliffs and boulder-protected slopes.

T. N. CAMPBELL

THE UNIVERSITY OF TEXAS

BEN R. HOWARD

MICHIGAN STATE COLLEGE

CLAUDE C. ALBRITTON, JR.

DODD N. OSBURN

SOUTHERN METHODIST UNIVERSITY

[4] Sir William Bragg, *Overseas Journal of the B. B. C.*, No. 67, January 12–18, 1941.

[1] H. P. Mera, letter to T. N. Campbell, September 3, 1940.

MANGANESE AND VITAMIN C

APPARENTLY a number of factors influence the ascor-ic acid content of tomatoes. Kohman and Porter[1] howed that the ascorbic acid content of young tomato lants was increased by solar rays. Again it was emonstrated that potash fertilization[2] influenced the mount found in the ripe fruit and that this roughly orrelated with the sugar content. Further, it was hown[3] that tomatoes grown upon certain soil types ad a larger ascorbic acid content than tomatoes rown on other soil types.

In a discussion of this problem with Dr. E. F. Kohman it was suggested that manganese might be an nfluencing factor. Since the available manganese is nown to vary in many soils, a survey of this problem as undertaken in 1939–40. The ascorbic acid content f the fruit from plants grown on twelve soils known o be low in available manganese averaged 200 milli-rams per liter of pulp, whereas samples from twelve oils known to be higher in available manganese nalyzed 269 milligrams.

In pot culture the application of 1 gram of $MnSO_4 \cdot 4\,H_2O$, in a localized area, to 15,000 grams f Sassafras sandy loam soil, testing pH 7.1, increased he ascorbic acid content in tomato pulp from 142 to 43 milligrams per liter. This is by no means all the nformation that leads us to believe that manganese s a factor in ascorbic acid formation but will serve o illustrate the point.

Since over a few pounds of soluble manganese per cre in the soil is known to be toxic to tomato plants, much work must be done to establish the optimum quantity, the proper method of application and the oil types requiring it. This problem is being investi-gated further, but owing to the nature of the problem t is reported at this time.

JACKSON B. HESTER
DEPARTMENT OF AGRICULTURAL RESEARCH,
CAMPBELL SOUP COMPANY, RIVERTON, N. J.

[1] E. F. Kohman and D. R. Porter, SCIENCE, 92: 561, 1940.
[2] J. B. Hester, *Amer. Fert.*, 93, November, 1940.
[3] J. B. Hester, *Proc. Soil Sci. Soc. America*, 1940.

CRYSTALLINE INSULIN DERIVATIVES

A NUMBER of various derivatives of insulin have been prepared, and attempts were made to obtain some of them in crystalline form, but without success.[1] We have recently described elsewhere[2] the preparation and physiological activity of several azo derivatives of insulin. Two of these derivatives, insulin-p-azophenylsulfonic acid and insulin-p-azobenzyltrimethylammonium chloride yielded perfectly shaped rhombohedral yellow crystals when not more than six groups were coupled to a single insulin molecule (mol. wt. taken to be 40,000). With insulin-p-azophenylsulfonic acids containing ten and fifteen groups only deformed ellipsoid shaped crystals were obtained, while attempts to crystallize insulin-p-azobenzyltrimethylammonium chloride containing fifteen groups failed. This suggests that in addition to the number of groups, there are other factors which affect the crystallization of such derivatives.

It is of interest that heavy atoms easily traced by x-ray analysis could be introduced by this method into the insulin molecule. Such compounds might be helpful in the x-ray analysis of insulin crystals. With this in view we prepared insulin-p-azoiodobenzene and insulin-p-azophenylarsonic acid in crystalline form.

The crystallization was carried out as suggested by Scott.[3] Most of the crystals obtained had edges of about 0.05 mm, although there were present a considerable number of very small crystals. A large amount of material remained amorphous and our yields were low. In several instances the crystals were tested for physiological activity and it could be demonstrated that the insulin action was maintained essentially to the same extent as it was in the amorphous insulin azo derivatives.[2]

E. H. LANG
L. REINER
THE EXPERIMENTAL RESEARCH LABORATORIES,
BURROUGHS WELLCOME & CO., U. S. A.,
TUCKAHOE, N. Y.

[1] C. R. Harington and A. Neuberger, *Biochem. Jour.*, 30: 809, 1936; R. F. Clutton, C. R. Harington and M. E. Yuill, *ibid.*, 32: 1111, 1938.
[2] L. Reiner and E. H. Lang, *Jour. Biol. Chem.*, in press.
[3] D. A. Scott, U. S. Pat. No. 2,143,590, January 10, 1939.

SCIENTIFIC BOOKS

ENGINEERING

Stress Analysis and Design of Elementary Structures. BY JAMES H. CISSEL, professor of structural engineering, University of Michigan. x + 335 pp. Illustrated. New York: John Wiley and Sons, Inc. 1940. $4.00.

AN engineer engaged in general practice will find this book a valuable reference work with regard to branches of civil engineering other than the one with which he may have special familiarity. It frankly does not go far enough to meet the specialist's needs in any one field, but it is truly unusual to find within the covers of a single 335-page volume so much of practical utility in each of the various fields of structural steel, both riveted and welded, timber construction, reinforced concrete, masonry and foundations.

Many formulas of importance are given and, while economy of space has not permitted their derivation, footnote references enable one to find their source

when necessary. While this procedure is not objectionable for the practicing engineer to whom the further references frequently mean merely a refreshing of his memory in the matters concerned, it is not considered a wise practice for the student, and therefore the value of the book for classroom work is open to question. The student should always be cautioned against accepting and using formulas of whose validity he has not personally assured himself, and it is too much to expect him continually to refer to the indicated sources in which demonstrations may be found.

The book contains an excellent body of fundamental material covering principles of statics and stress analysis with much up-to-date information regarding dead and live loads, wind forces, earthquake forces and lateral pressures on walls for guidance in the preparation or checking of designs. It is a little unfortunate that in expressing the Theorem of Three Moments, equation (76), the author did not follow the procedure employed by Timoshenko and McCullough, to whose book he refers in a footnote. If the concentrated loads in the two spans are located by their respective distances from the nearer end support, the result is a much simplified expression. Strangely enough, however, most writers upon this subject have followed the same procedure as the author.

The design section of the book is more complete in the fields of timber and reinforced concrete than in that of structural steel. With the exception of the plate girder, very little attention is given to the design of steel members. Perhaps this is well. The steel specialist frequently needs to inform himself regarding details of timber construction, but the timber specialist would probably be wise not to attempt the design of steel structures because of the highly developed technical practice involved.

The material covered is carefully and attractively presented and has been selected with wise discrimination in view of its necessarily abbreviated character. The book is to be highly recommended for a place convenient of access upon the shelf of the practicing engineer.

FRANCIS P. WITMER
UNIVERSITY OF PENNSYLVANIA

EMBRYOLOGY OF AN ECHIUROID WORM

The Embryology of the Echiuroid Worm Urechis caupo. By W. W. NEWBY. 219 pp. American Philosophical Society, Memoir XVI. $2.00.

THIS memoir deals with the development of an echiuroid worm from the time of fertilization until the larva undergoes its metamorphosis and assumes the adult form. It is one of the most complete and accurate studies which has been made in the case of any invertebrate. Furthermore, the clearness of style, the accuracy of the illustrations and the lack of bias in the evaluation of the work of others and in the formulation of general conclusions places this study on a high plane indeed.

The work comprises ten main sections of which six are concerned primarily with the problem of development. The first of these is a running account of the changes which ensue from the stage of fertilization to the assumption of the adult form. In this process the history of each cell is accurately traced to the 148 cell stage, which marks the beginning of gastrulation. Beyond this point there is a detailed description of the various body regions, their ciliation and the shifting of the embryonic areas and axes. There likewise is a complete account of the series of changes which transform the archenteron into the complicated digestive system of the adult. The ecto- and entomesoblast also are traced from their point of origin to where, in certain cases, they have attained their final form. In this connection it is demonstrated that the term "larval mesenchyme" is a misnomer. At no stage have its cells been found to degenerate, and, on the other hand, there are numerous instances, where, as functional muscle fibers, they extend from the esophagus and stomach to the body wall.

The development of the nervous system and entomesoblast involves the problem of the extent to which metameric segmentation exists in the echiuroids. The brain and ventral cord develop as in annelids, and after their union the cord develops twelve enlargements, which correspond to an equal number of rows of ectodermal glands. These enlargements or "segments" later subdivide irregularly to form from two to three secondary subdivisions. During this process the entomesoblasts have formed a pair of coelomic cavities whose subsequent fusion results in the single cavity of the adult. At no stage is there any indication of metamerism of the coelom or of any other structure of entomesoblastic origin. In other words, this is a case of pseudometamerism of the same general type as the duplication of the shell plates of chitons.

In the concluding sections the author reviews the developmental history of the flatworms, annelids, mollusks and echiuroids. All these are characterized by the spiral type of cleavage, all pass through a trochophore stage, and conceivably, therefore, all may be the descendants of an ancestral trochozoon. These fundamental resemblances, however, are largely obscured by later evolutionary changes which are of phyletic rank in all but the echiuroids. The author is convinced that this last-named group likewise is entitled to rank as a distinct phylum.

While this study will be of the highest value to the systematist and the student of normal development, it also will serve, to an equal degree, the needs of the experimentalist. Urechis, at all stages of growth, is

an unusually hardy organism, and in other respects it is especially favorable material for the study of vital phenomena. And equally important is the fact that henceforth the modifications produced by experimental methods may be analyzed in the light of normal development.

HAROLD HEATH

HOPKINS MARINE STATION,
PACIFIC GROVE, CALIF.

REPORTS

TEN-YEAR RESEARCH PROGRAM OF THE VIRGINIA GEOLOGICAL SURVEY

WITH the appointment in 1929 of a new state geologist and of an assistant state geologist, a long-range program of field research by the Virginia Geological Survey was planned. The objectives of this program were chiefly three-fold: to obtain fundamental geologic data, mainly stratigraphic and structural, in a large part of the state which lacked detailed field mapping and studies; to study thoroughly the geologic relations of certain mineral resources; and to obtain as much data as possible upon the characteristics and uses of these resources.

The 40,262 square miles of land area in Virginia includes parts of five geologic or physical provinces—from the Atlantic coast westward into the Appalachian Plateaus. The fact that the 440-mile southern boundary is approximately transverse to the "grain" of the Appalachian Highlands and the Coastal Plain indicates the nature of the geologic problems to be studied. It should be noted also that the annual production value of the mineral resource industries in the state has, in general, ranked increasingly higher during the last two decades.

In planning the program, the wide range of uses of the field data was one controlling factor. The primary uses of technical data obviously would be by geologists and mining and industrial engineers. Much of the geologic data has had basic use in the planning of normal community and industrial development, and recently some have been very useful in national defense projects. Part of the program was planned for the distinct purpose of interpreting geology and mineral resources in a manner to be of use in the schools in the state and of interest and value to laymen.

The field research program was definitely started in 1930–1931, as certain appropriations became available. Its development over a decade can now be summarized. The emphasis in this brief summary is upon types of research projects that have been completed, or are nearing completion. More progress in research was made during the earlier part of the decade, despite the depression, because more funds were then available for field investigations. During this decade, 24 bulletins based on field research projects, having a total of about 3,000 octavo pages of text and about 775 halftone illustrations and nine geologic maps in colors, were published. In the same period, almost 40 other field research projects have progressed to the stage where the manuscripts are on hand, or are being prepared, for publication as Survey reports. These projects cover many phases of the broad field of Virginia geology and its manifold economic applications.

It may be noted that at first in this decade two geologists constituted the regular technical staff of the Geological Survey and that another geologist was added a few years ago. Thus many of the research projects have necessarily been carried forward by other geologists—25 of them—who were from year to year employed seasonally. Some of these men were graduate students engaged in field research as a part of their work for Ph.D. degrees at various universities. In addition, eight geologists of the U. S. Geological Survey staff worked during this decade on cooperative projects in Virginia.

All this research by the State Geological Survey has been done as a division of the Virginia Conservation Commission, which was created in the reorganization of the state government by Governor Byrd in 1926.

Twenty projects were completed during the decade by the publication of reports in the regular bulletin series of the Survey. Projects in which basic geology predominates included Roanoke County with map[1] (34),[2] James River marble belt with map (39), Appalachian Valley geologic map with explantory text (42), Goochland County with map (48), Appalachian Valley geology (52, in press), Warrenton quadrangle in the northern Piedmont Upland and Triassic Lowland (54), and Draper Mountain area in Pulaski and Wythe counties (55). Industrial mineral (nonmetallic) projects were Coastal Plain sand and gravel (32), pegmatite deposits (33), kyanite deposits with map (38), Giles County marble prospects (40), and barite deposits (53). Metals included zinc and lead deposits with map (43) and gold (44). Ground-water projects comprised thermal springs with map (36), ground water of northern Virginia (41, preliminary summary, and 50, final report), and ground water in Shenandoah Valley (45). Educational, or more or less nontechnical publications for use in schools and by laymen, were: Virginia caverns (35), The Peninsula (37), mineral resources (47), and Russell County (49). In addition, two volumes of "Contributions to Virginia Geology" were published (46, with 13 papers, and 51,

[1] Map means geologic map in colors.
[2] Numbers in parentheses are serial numbers of published bulletins.

with 8 papers). Obviously most of these publications contain many data on, and interpretations of, basic geology which are of great importance in scientific and economic investigations, whether for peace-time welfare or industrial activities under the urge of national defense programs.

Projects initiated during the past decade and still in various stages of progress toward completion for published bulletins may be briefly summarized as follows:

Basic geologic research primarily pertains to 14 projects, namely, Great Gossan Lead district in the southwestern Blue Ridge province,[3] geology of Frederick and Clarke counties (transverse of the northern Shenandoah Valley),[3] Natural Bridge district,[4] geology of Giles County,[3] Hot Springs district, Burkes Garden quadrangle (Tazewell County),[3] northwest front of Blue Ridge province in southwest Virginia, Eocene formations,[4] Lower Devonian, geology of Abingdon 30-minute quadrangle, Amherst quadrangle (15′), Buena Vista quadrangle (15′), Lexington quadrangle (15′), and Stony Man quadrangle (15′).[4]

Research involving chiefly industrial minerals includes 7 projects: Commercial granites,[4] diatomite, Valley limestones, southwestern Piedmont limestones, mineral industries, slates,[3] and talc and soapstone.[3] One project is concerned with fuels, namely, natural gas possibilities in southwest Virginia,[3] which is in cooperation with the U. S. Geological Survey.

Projects in progress that are in large measure educational, that is, for reports in non-technical language for use in schools and by laymen, and which in addition will afford considerable basic data are as follows: Common rocks and minerals, geology of Virginia, geologic history of Shenandoah National Park, natural wonders, physical features, rocks and land forms in state parks, guide-book of the Lee Highway (U. S. 11), and separate "Outlines" of the geology and mineral resources of Augusta, Bath, Frederick,[3] Scott,[4] Smyth,[3] Tazewell, and Wythe[3] counties.

Ground-water investigations in cooperation with the U. S. Geological Survey consist of two projects, namely, the southern Coastal Plain[6] and the middle Coastal Plain.

ARTHUR BEVAN
STATE GEOLOGIST OF VIRGINIA

[3] Field work completed.

[4] Manuscript report and geologic map completed for publication.

SPECIAL ARTICLES

ABSORPTION OF PELLETS OF CRYSTALLINE HORMONES

THE introduction of the pellet method by Deanesley and Parkes[1] has made possible a much more efficient administration of many of the crystalline hormones. Due to the present scarcity of available data on the relative absorption rates of hormones in pellet form, it seemed advisable to attempt to obtain such information.

Using a modification of the Hartman[2] apparatus, cylindrical pellets of various crystalline hormones were prepared; all these pellets had the same diameter and had been subjected to the same amount of compression. (The modified apparatus and the detailed results will be described in a later article.) The length of a pellet varied according to its weight (in these experiments, 1.6 mgm = 1 mm of length). The pellets used weighed 6 to 10 mgm each. They were implanted subcutaneously, under ether anesthesia, in the lower right abdominal quadrants of 97 normal, healthy, sexually mature male and female rats. One freshly made, full-sized pellet, after careful weighing, was implanted in each rat. Each rat and each pellet were used only once. After varying intervals had elapsed the pellets were removed, cleaned, dried to constant weight in a desiccator and reweighed. Each rat was also weighed when the pellet was implanted and when it was removed.[3]

The data reported below were obtained from the implantation and removal of 20 testosterone, 16 testosterone monopropionate, 12 methyl testosterone, 14 stilbestrol, 17 desoxycorticosterone and 18 progesterone pellets. The loss of weight of each of these pellets, expressed in terms of per cent., was plotted graphically against the number of days the pellet had been *in situ*. Such a graph showed surprisingly little scattering from a nearly linear curve. Pellets could be and were successfully removed and weighed until they were about 90 per cent. absorbed. Under the conditions of the experiment, it was found that 90 per cent. absorption of the pellets required the following amounts of time: desoxycorticosterone, 27 days; testosterone, 31 days; methyl testosterone, 36 days; stilbestrol, 51 days; testosterone monopropionate, 61 days; progesterone, 88 days. It is believed that the uniform technique employed makes these results directly comparable. The sex of a rat appeared to have no constant differential effect on the absorption rate.

The absorption curves were either linear or else showed with time only a slight gradual decrease in the absorption rates, a fact which agrees with theoretical

[1] R. Deanesley and A. S. Parkes, *Proc. Roy. Soc.*, Ser. *B*, 124: 279–298, 1937.

[2] C. G. Hartman, *Endocrin.*, 26: 449–471, 1940.

[3] The author wishes to express his indebtedness and gratitude to Mr. Bruce Valentine for construction of the pellet press, to the staff of the Edward Martin Biological Laboratory of Swarthmore College for providing facilities and animals to begin the experiment and to Dr. Erwin Schwenk, of the Schering Corporation, for donating the hormones used.

alculations and which should be of importance in the xperimental and clinical use of pellets. Theoretical onsiderations indicate that the absorption rate may ave decreased rapidly after 90 per cent. absorption ad occurred.

Within a week after implantation each pellet became losely invested with a thin, non-adherent tissue capule. Histologically, the capsules consisted of circumferentially and compactly arranged connective tissue ells and fibers. The capsules were of fairly uniform tructure but varied in thickness roughly according to heir age. In a few instances, perhaps as a result of ocal infection, the capsules were markedly thickened nd vascular; in these cases the absorption rate showed fter the first 10 days either moderate increase or a moderate decrease.

Stilbestrol invariably caused losses in body weight; such losses ranged from 0.3 to 3.6 gm (average) for each day the pellet was *in situ*. Weight losses occurred in some but not all of the other rats.

The results of additional observations, now in progress, on the relative absorption rates of several other steroid hormones indicate that estrone and alpha-estradiol show relatively very slow absorption and that, like testosterone propionate (see above), esterified alpha-estradiol and desoxycorticosterone are absorbed more slowly than the corresponding free forms.

T. R. FORBES

DEPARTMENT OF ANATOMY,
JOHNS HOPKINS UNIVERSITY

ANTAGONISTIC ADRENAL AND PITUITARY EFFECTS ON BODY SALTS AND WATER*

IN a number of papers published during the past four years we have described important related effects on electrolyte and fluid balance brought about through adrenal and hypophyseal activities.[1,2,3,4,5,6] In 1938 it was shown that a hormone contained in our cortico-adrenal extracts acted as a diuretic agent and antagonized the anti-diuretic hormone of the posterior lobe of the pituitary.[4,5] The conditions proposed by Smith[7] for a diuretic factor were shown in our experiments to be fulfilled in every respect by the cortico-adrenal hormone.[4] Recently we have extended our experiments and tested the more specific adrenal substance, desoxycorticosterone, in its possible relationship to water intake and urinary chloride and fluid output under different conditions. Some experiences with this crystalline factor reported recently by other workers[8,9] confirm our earlier results obtained with whole extracts of the adrenal cortex.

Observations have been made in the present experiments on normal, adrenalectomized and hypophysectomized rats, amplifying our previous work on opossums. Operated animals were allowed several days for recovery before metabolism tests were run, and then studied at intervals for periods up to 30 days (adrenalectomized rats) and 80 days (hypophysectomized animals) after operation. Two to four "rest" days were given between runs. Adrenalectomized animals were occasionally given weak saline and small amounts of cortico-adrenal extract on off-test days, sufficient to keep them in a state of chronic insufficiency; hypophysectomized rats also were observed in the chronic condition, *i.e.*, when showing only slight diabetes insipidus. The 12-hour tests were made with water allowed *ad. lib.*, usually without previous fasting; in a few series in which runs were carried out after a 6-hour fast, no significant differences were observed. Results and other experimental details are shown in Table 1.

TABLE 1

EFFECTS OF DESOXYCORTICOSTERONE† AND POST-PITUITARY EXTRACT‡ ON WATER INTAKE AND URINE AND CHLORIDE OUTPUT IN RATS UNDER DIFFERENT CONDITIONS

Experimental conditions	No. of cases	Water intake cc/100 gm rat	Urine cc/100 gm rat	Urinary chlorides mg/cc
Unoperated rats, no treatment	34	1.7	1.5	2.78
Unoperated rats, desoxycorticosterone-treated	12	2.9	1.9	1.50
Unoperated rats, post-pituitary extract	10	0.6	1.1	16.20
Adrenalectomized, untreated	10	3.4	2.1	3.30
Adrenalectomized, desoxycorticosterone-treated	11	7.8	5.0	1.11
Adrenalectomized, post-pituitary extract	6	0.9	1.3	8.25
Hypophysectomized, untreated	26	2.3	1.9	2.12
Hypophysectomized, desoxycorticosterone-treated	52	5.9	5.2	0.38
Hypophysectomized, post-pituitary extract	10	0.8	1.7	6.40
Hypophysectomized, desoxycorticosterone and post-pituitary extract	12	1.9	1.9	6.09

† Desoxycorticosterone acetate ("Cortate"), kindly supplied by the Schering Corporation.
‡ Post-pituitary extract ("Solution," U.S.P.), kindly supplied by Squibb and Sons.
Metabolism tests in each case extended over 12 hours. Small doses of the above preparations were administered every two hours.

It is clear at a glance that in all groups of animals, normal, adrenalectomized and hypophysectomized, the effects of desoxycorticosterone are of opposite sign to those of post-pituitary extract. Desoxycorticosterone invariably increased water intake and urine output,

* Aided by a grant from the National Research Council.
[1] H. Silvette, *Am. Jour. Physiol.*, 117: 405, 1937.
[2] H. Silvette and S. W. Britton, *Am. Jour. Physiol.*, 121: 528, 1938.
[3] H. Silvette, *Proc. Am. Physiol. Soc.*, fiftieth annual meeting, Baltimore, 1938, p. 188.
[4] H. Silvette and S. W. Britton, SCIENCE, 88: 150, 1938.
[5] H. Silvette and S. W. Britton, *Am. Jour. Physiol.*, 123: 630, 1938.
[6] E. L. Corey, H. Silvette and S. W. Britton, *Am. Jour. Physiol.*, 125: 644, 1939.
[7] H. W. Smith, "The Physiology of the Kidney," New York, 1937, p. 229.
[8] C. Ragan, *et al.*, *Am. Jour. Physiol.*, 131: 73, 1940.
[9] M. Schweizer, *et al.*, *Am. Jour. Physiol.*, 132: 141, 1941.

and at the same time reduced urinary chlorides, both in concentration and total amount excreted. Entirely reversed effects were observed after post-pituitary extract administration. Further, when post-pituitary extract and desoxycorticosterone were injected together, the action of the former substance always appeared dominant. The increased chloride output in untreated adrenalectomized rats, and decreased output along with increased water intake and urine secretion in untreated hypophysectomized animals, may be noted. Young normal rats about 125 gms. in weight responded to desoxycorticosterone better than older animals.

To be emphasized also are the large increments in fluid exchange effected by desoxycorticosterone, and the marked increases in chloride elimination after post-pituitary injection. In the former case the changes in water intake and urine output approximated 100 per cent., and in the latter (chloride output) 100 to 500 per cent. in different series. Extraordinarily large amounts of chloride may thus be forced from the body through post-pituitary action.

The water-intake: urine-output ratios (W/U) were greatly reduced in all cases by post-pituitary extract —by 50, 55 and 70 per cent. in the 3 series. In contrast to the resultant deficits of water in pituitary-treated animals, there were apparently increases in body water in normal rats treated with desoxycorticosterone. Hematocrit readings were in keeping with these findings: in all cases tested in which desoxycorticosterone was given, the total cell volumes fell continuously over a period of 12 hours.

It appears clear from the results above, therefore, that the adrenal cortex and the post-pituitary tissues elaborate principles which specifically counteract each other in their effects on the kidney, and on salt and water balance in the body. In this connection one may recall that desoxycorticosterone has recently been found responsible for severe reactions (edema, hypertension) and some deaths in the clinic because of overdosage or cumulative action. Possible utilization in dangerous situations of the physiological antagonist to desoxycorticosterone, post-pituitary extract, should of course be kept in mind.

It may be observed that desoxycorticosterone does not exactly reproduce the effects that are brought about by cortico-adrenal extract. The action of the latter is much greater, particularly on carbohydrate levels in the body.[10] Moreover, there are surely other hormones besides those controlling body water to be found in whole cortico-adrenal extract and in post-pituitary preparations. The results herein show that the organism is intimately dependent on a balanced relationship between the adrenal and pituitary mechanisms for normal salt and water regulation in probably all body fluids and tissues.

S. W. BRITTON
E. L. COREY
PHYSIOLOGICAL LABORATORY,
UNIVERSITY OF VIRGINIA MEDICAL SCHOOL

[10] S. W. Britton and E. L. Corey, *Am. Jour. Physiol.*, 129: 316, 1940.

NUTRITIONAL FACTORS CONCERNED IN RUSTING OF ALBINO RATS

THERE have been several recent reports in the literature concerning the achromotrichia factor and the rusting factor which offer some differences in observations. György and his coworkers[1] report that graying of black or piebald animals and, presumably, rusting of albino animals when placed on a suitable diet can be prevented by addition of pantothenic acid to that diet. Dimick and Lepp[2] report that pantothenic acid decreases graying of fur. Unna[3] reports that with 80 μgm of pantothenic acid daily only fleeting signs of fur impairment were observed. Nielsen, Oleson and Elvehjem[4] have published a procedure for the separation of a substance which is not pantothenic acid but which prevents nutritional achromotrichia. Williams[5] has found that nutritional achromotrichia could not be cured by pantothenic acid when butter fat was omitted from the diet.

We have noted the occurrence of rustiness developing in our experimental albino rats during investigations of synthetic diets. It seemed that these results were worth mentioning because, if they are confirmed, they may open another way to attack the question of the relationship of pantothenic acid to nutritional achromotrichia and also the question of the identity of the achromotrichia factor and the rustiness factor.[6] Our observations were purely incidental and the problem will not be investigated further in our laboratories.

The basal diet used contains 68 per cent. sucrose, 18 per cent. vitamin-free casein, 7 per cent. butter fat, 2 per cent. cod liver oil, 1 per cent. Wesson oil and 4 per cent. salts.

In the first experiment a supplement containing 15 μgm thiamin hydrochloride, 20 μgm riboflavin, 250 μgm nicotinic acid, and 20 μgm choline hydrochloride was fed daily six days a week. In every case rustiness was noted in 4 weeks. If 20 μgm of pyridoxine was added rustiness was noted in 4 to 7 weeks. Any sign

[1] P. György, C. E. Poling and Y. Subbarow, *Proc. Soc. Exptl. Biol. Med.*, 42: 738, 1939; *Jour. Biol. Chem.*, 132: 789, 1940; P. György and C. E. Poling, SCIENCE, 92: 202, 1940.
[2] M. K. Dimick and A. Lepp, *Jour. Nutrition*, 20: 413, 1940.
[3] K. Unna, *ibid.*, 20: 565, 1940.
[4] E. Nielsen, J. J. Oleson and C. A. Elvehjem, *Jour. Biol. Chem.*, 133: 637, 1940.
[5] R. R. Williams, SCIENCE, 92: 561, 1940.
[6] S. Ansbacher, SCIENCE, 93: 164, 1941, has shown that *p*-aminobenzoic acid is the chromotrichia factor for black or piebald rats. Whether this substance prevents rustiness in albino rats is still to be ascertained.

lermatitis or rustiness could be cured or prevented addition of 4 gm of potato to the daily diet.

n the second experiment 20 μgm of pantothenic acid 20 μgm of pyridoxine were added to the supple- t and the choline was increased to 20 mgm. Again tiness was noted in 5 to 6 weeks.

n the third experiment pantothenic acid was in- sed to 40 μgm, keeping the rest of supplement the e as in the second experimnt. No rustiness was nd.

n a fourth experiment the pantothenic acid was in- sed to 80 μgm, and again no rustiness developed. s experiment extended over 13 weeks with no un- ard symptoms developing in that time. However, the choline was omitted from the diet, rustiness eloped in 6 weeks regardless of the high level of ntothenic acid.

he conclusions that can be drawn from these ex- iments are that rustiness can be produced with the ino rat provided choline or pantothenic acid is itted from the diet and that it can be prevented if the diet is supplemented by at least 40 μgm of pantothenic acid and by 20 mgm of choline (this may be well above the actual requirement). The implication is that no matter what the factors are that prevent development of rustiness in albino rats, the liver must play an important role in their metabolism. Our observations on pantothenic acid agree with those of György and his coworkers. In a communication from Dr. György it is stated that he included 1 gram of choline per kilogram of the diet used in the experiments reported by him and his coworkers.

We wish to acknowledge our indebtedness to Dr. R. J. Williams for a generous sample of sodium pantothenate and to Merck and Company for generous samples of calcium pantothenate and pyridoxine. We also thank Dr. Paul György and Dr. R. R. Williams for their suggestions and criticisms.

HARRY S. OWENS
MARVIN TRAUTMAN
ELLA WOODS

UNIVERSITY OF IDAHO

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN APPARATUS FOR PRODUCING CONSTANT GAS MIXTURES[1]

STUDIES on anoxia have often been limited because the prohibitive cost and variation in composition commercial gas mixtures. With these facts in mind, apparatus has been designed by means of which nstant mixtures of atmospheric air and nitrogen can made economically.

As seen in the diagram, two wet gas meters of three-liter capacity[2] are connected by means of ladder chain G and sprocket gears H and H′. Nitrogen from a cylinder is introduced into the first meter A after passing through bottle C. Water manometer E acts as a safety valve. The nitrogen originates as compressed gas and passes through meter A, creating enough mechanical force to turn meter B at a corresponding speed. Air, drawn into meter B as it revolves, passes into bottle D, where it mixes with nitrogen from meter A. Any change in rate of flow of nitrogen through meter A causes a similar change in

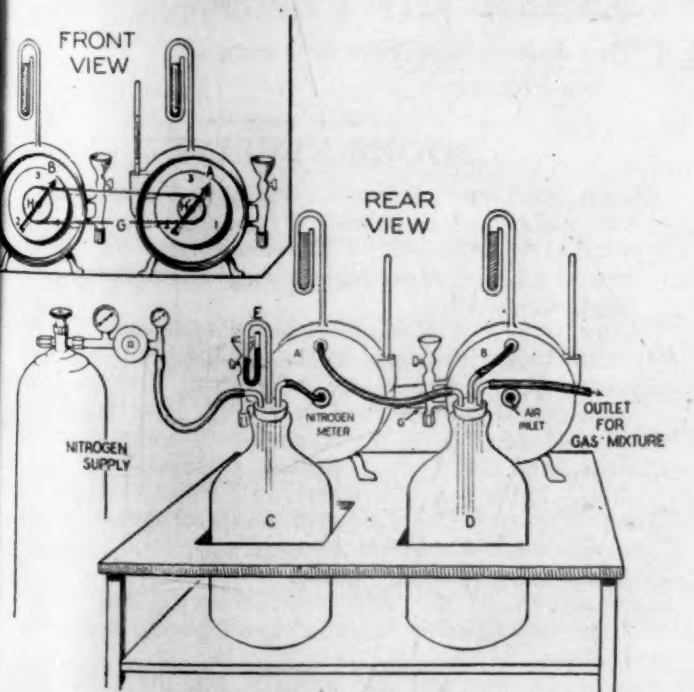

FIG. 1

TABLE 1

ANALYSIS OF GAS MIXTURES FROM THE APPARATUS (HALDANE HENDERSON METHOD)

Gear Ratio H : H′	Observed O_2, Vol. Per cent.	Observed CO_2, Vol. Per cent.	Observed N_2, Vol. Per cent.	Expected N_2, Vol. Per cent.
4 : 3	11.82	0.05	88.13	88.02
4 : 3	11.72	0.07	88.21	
1 : 1	10.33	0.01	89.66	89.51
1 : 1	10.22	0.01	89.77	
1 : 2	6.94	0.04	93.02	93.03
1 : 2	6.89	0.03	93.08	
1 : 3	5.35	0.01	94.64	94.75
1 : 3	5.38	0.03	94.60	
1 : 4	4.17	0.03	95.80	95.80
1 : 4	4.18	0.02	95.80	

[1] This study was aided by a grant made to Dr. G. W. horn by the Committee on Research in Endocrinology, ational Research Council.

[2] American Meter Company, Model A L 18–3 (3 liters).

rate of rotation of meter B, keeping the composition of the mixture constant at all times. The apparatus is not designed to work against a large back pressure. Excess moisture can be removed from the gas mixture by passing it through a bottle immersed in cold running water.

Table 1 shows the composition of mixtures of nitrogen and atmospheric air produced with various gear ratios (H : H′) at a rate of flow of 2–8 liters per minute. An advantage of this apparatus is its ability to produce gas mixtures of constant composition, despite fluctuations in the rate of flow.

ROGER A. LEWIS
GEORGE F. KOEPF
THE JOHNS HOPKINS UNIVERSITY AND HOSPITAL

SIMPLE FLOOR-NET FOR CATCHING THE ESCAPED LABORATORY RODENT

To save considerable time lost through the employment of many inefficient devices to capture animals that have escaped from their cages, I have constructed a simple net which may be used for the common laboratory rodents, rat, mouse and guinea pig, and in a larger size for rabbits.

Rats and mice, as well as guinea pigs to a lesser extent, are negatively phototropic. For example, I have seen escaped rats and mice kill themselves because of this tendency. By spying solid, black objects such as table legs or iron stoves and by considering these to be darkened holes in their momentarily confused landscape, they have crashed headlong into them. Therefore, the object into which the rodent should run ought to be black and preferably of soft material such as cloth.

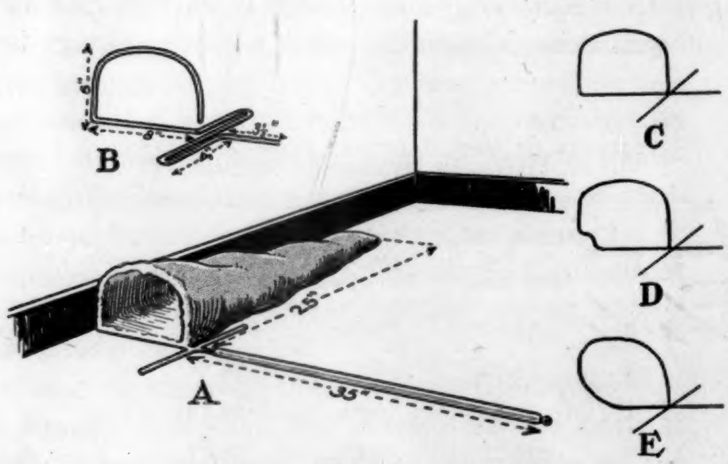

FIG. 1

Except on rare occasions laboratory rodents run along the walls, gauging their distance from the wall with their vibrissae. Therefore the device for catching them should fit snugly to the wall.

With a consideration of these special demands made upon such a device by rodent behavior, I have constructed a net as represented in Fig. 1 A.

A frame of 5/32″ galvanized iron wire is bent shown in Fig. 1 B to form net opening shape wide × 6″ high), supporting arms (4″ long) handle insert ($3\frac{1}{2}$″ long). To render the frame it is soldered or brazed together where the net-ope shape, supporting arms and handle insert come gether.

The net-opening shape will vary in size with animals for which it is employed, but for rats, and guinea pigs the dimensions given here will satisfactory. The contour will vary with the pro of the laboratory wall where it joins the floor. He the net-opening shape may be of forms such as th shown in Fig. 1 C, 1 D and 1 E. The handle is 3 long and the net bag 25″ long, as represented in F 1 A.

A black cloth bag is sewed to the net-opening fra

To use the floor-net, it is merely laid on the fl with the end of the net-opening at right angles to wall and fitting the wall profile. The net-opening maintained in a solidly upright position by the su porting arms. The animal is driven into the bag the net-opening is closed by turning it under or ov the net bag. If the animal is being driven from direction opposite to that toward which the net-ope ing is oriented, merely turn the net inside out proceed as before.

If wild rats are being housed in Wistar Instit 2-compartment-type cages, a smaller net of simi design but lacking the supporting arms may be h over the intercompartment door in one compartme and the rats readily driven through the door into net when specimens are wanted for experiment purposes.

CLYDE E. KEELE
THE WISTAR INSTITUTE OF ANATOMY AND BIOLOGY

BOOKS RECEIVED

FRANK, PHILIPP. *Between Physics and Philosophy.* P 238. Harvard University Press. $2.75.

GREENLEAF, ALLEN R. *Chemistry for Photograph* Pp. xi + 177. American Photographic Publishing C Boston. $2.00.

HARDY, G. H. *A Mathematician's Apology.* Pp. vii+ Cambridge University Press, Macmillan. $1.00.

JESSEN, KNUD and RAGNAR SPÄRCK, Editors. *Dan Scientific Investigations in Iran. Part II.* Pp. Illustrated. Einar Munksgaard, Copenhagen. Cr.

LANDSBERG, HELMUT. *Physical Climatology.* Pp. 283. 79 figures. Pennsylvania State College.

LEY, WILLY. *The Lungfish and the Unicorn: an E cursion into Romantic Zoology.* Pp. 305. Illustrat Modern Age Books. $2.75.

LLEWELLYN, F. B. *Electron-Inertia Effects.* Pp. vii 104. 13 figures. Cambridge University Press, Ma millan. $1.75.

LOGAN, H. BRITTON and JEAN-MARIE PUTNAM. *Scien in the Garden.* Pp. xiv + 255. Duell, Sloan and Pear New York. $2.50.

WOODRUFF, L. L., Editor. *Development of the Scienc Second Series.* Pp. 336. Yale University Press. $3.